OIPE
APR 30 2005
PATENT & TRADEMARK OFFICE

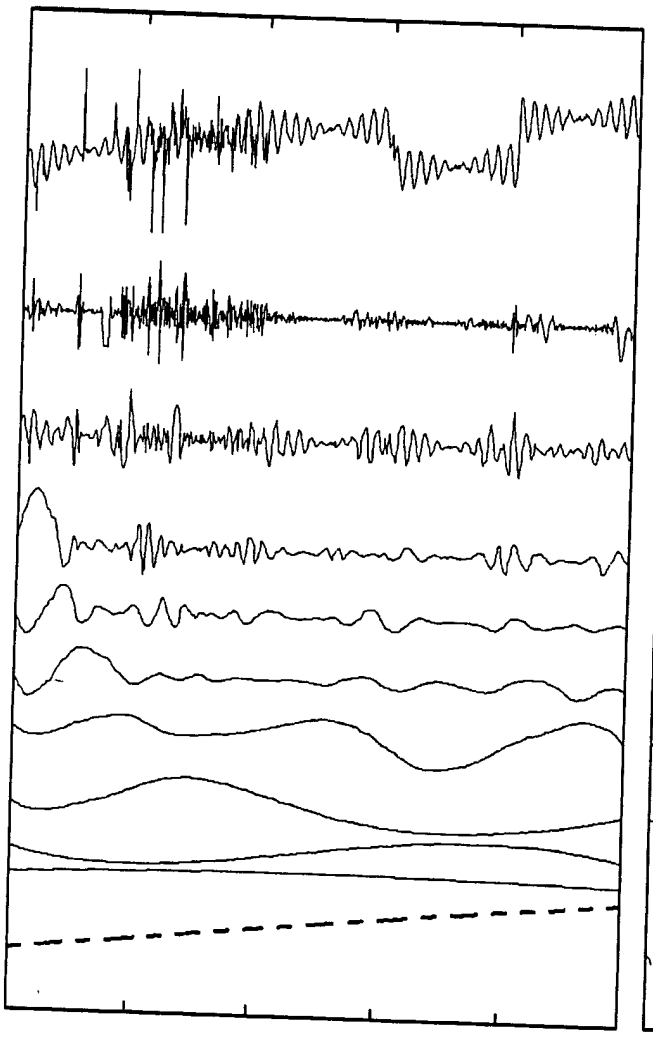


Fig. 1(a)

PRIOR ART

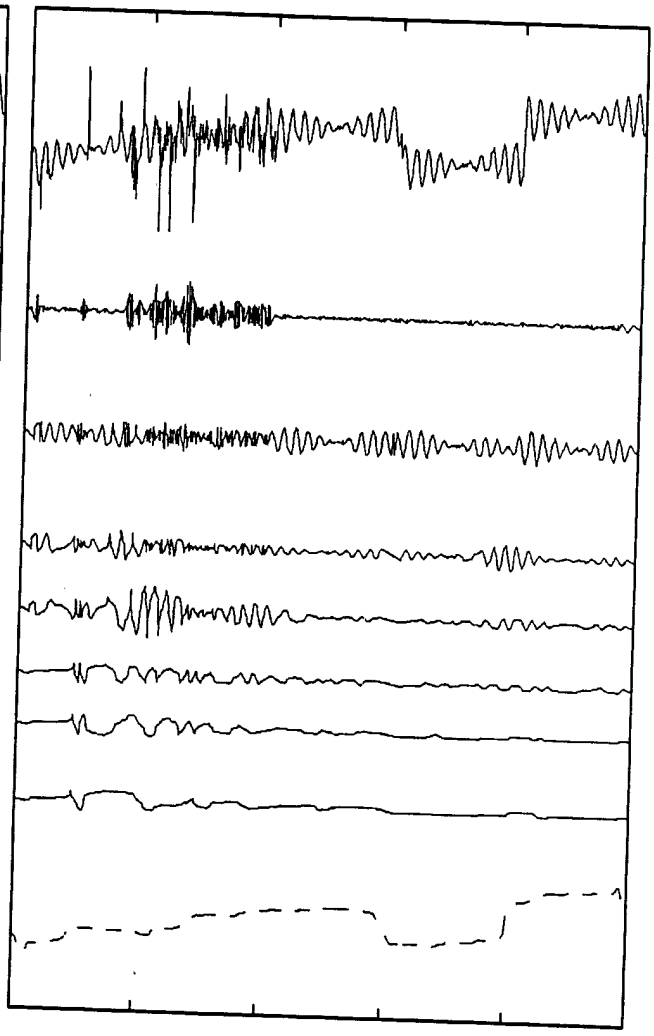
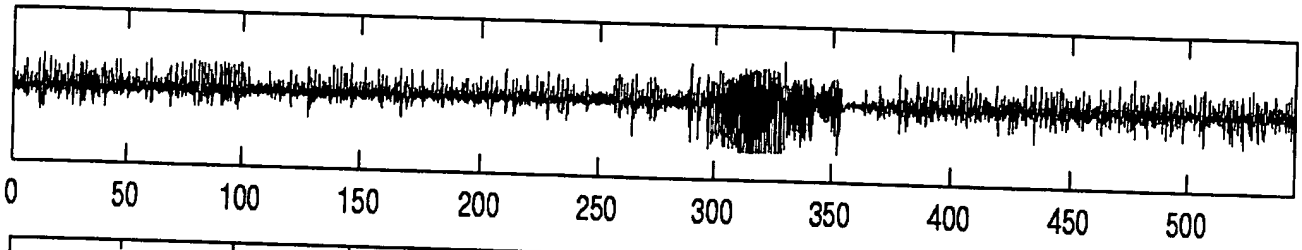


Fig. 1(b)

Fig. 2(a)



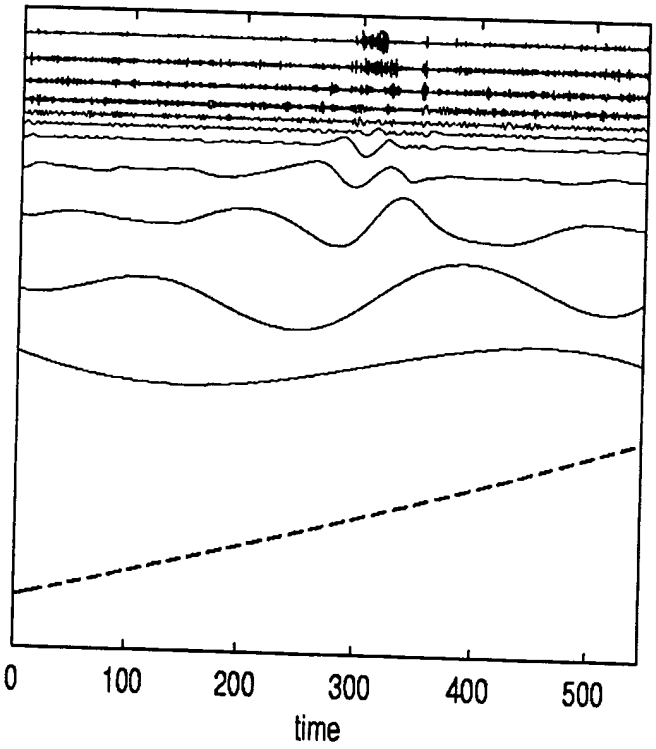


Fig. 2(b)

PRIOR ART

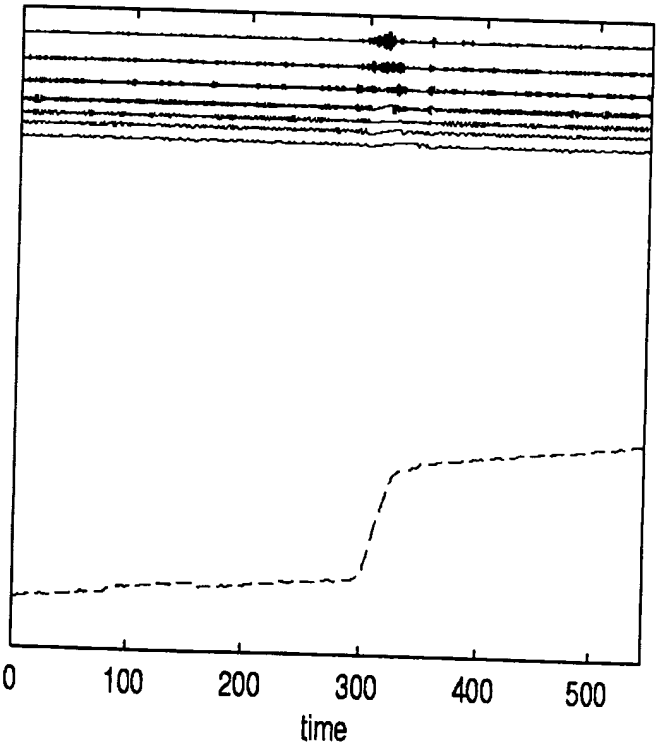
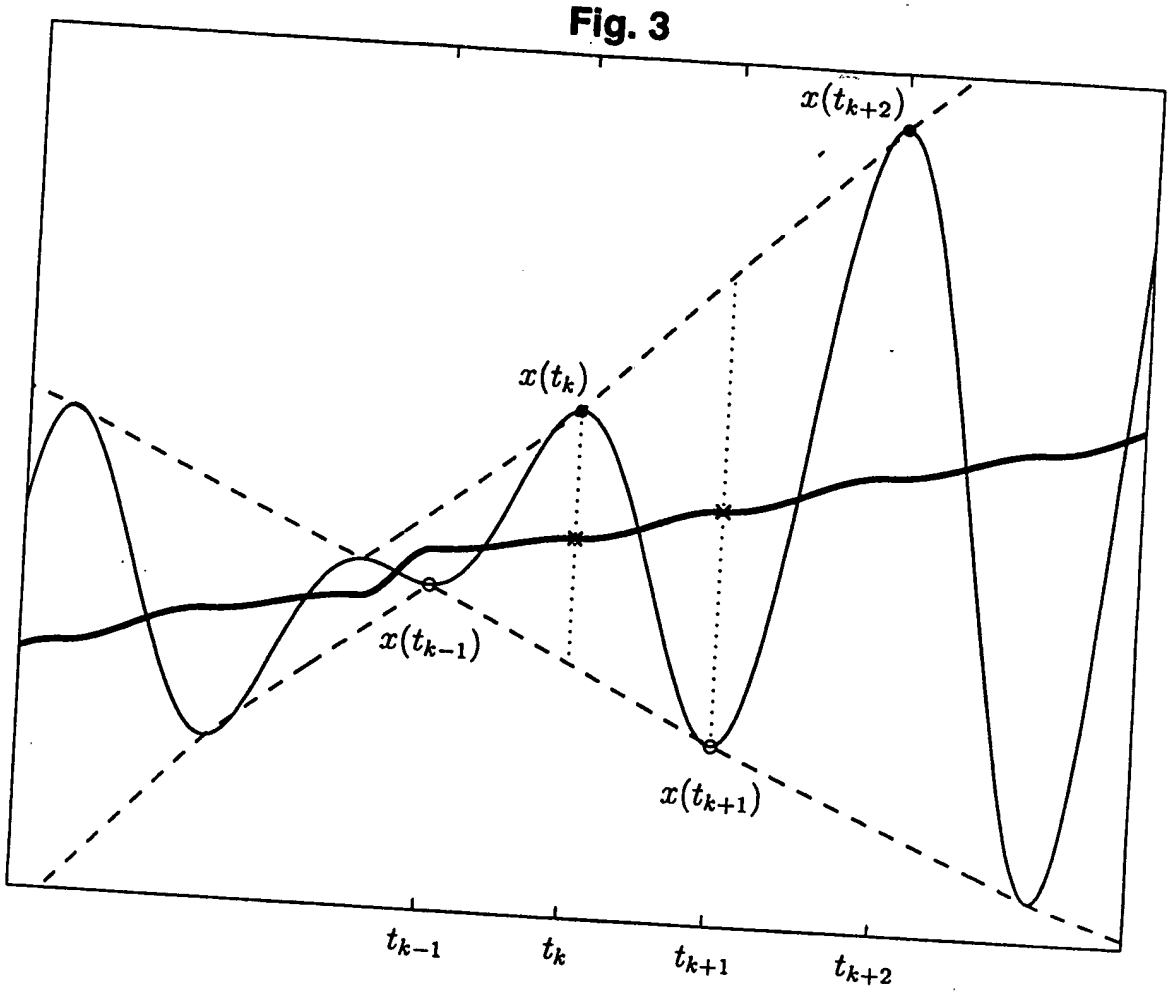


Fig. 2(c)

Fig. 3



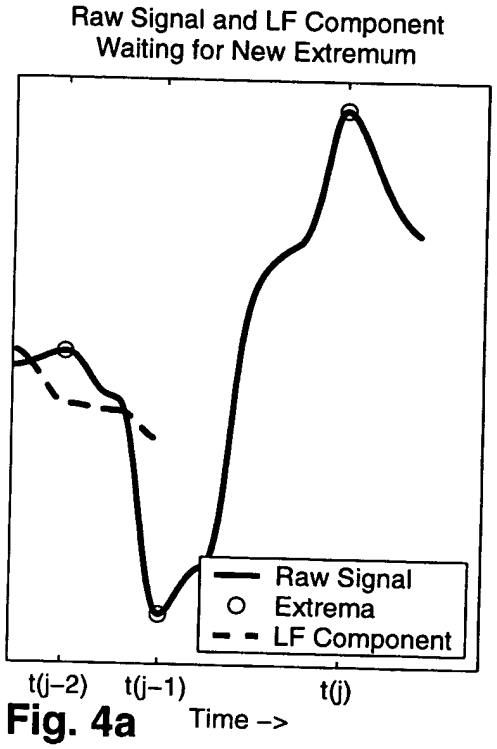


Fig. 4a

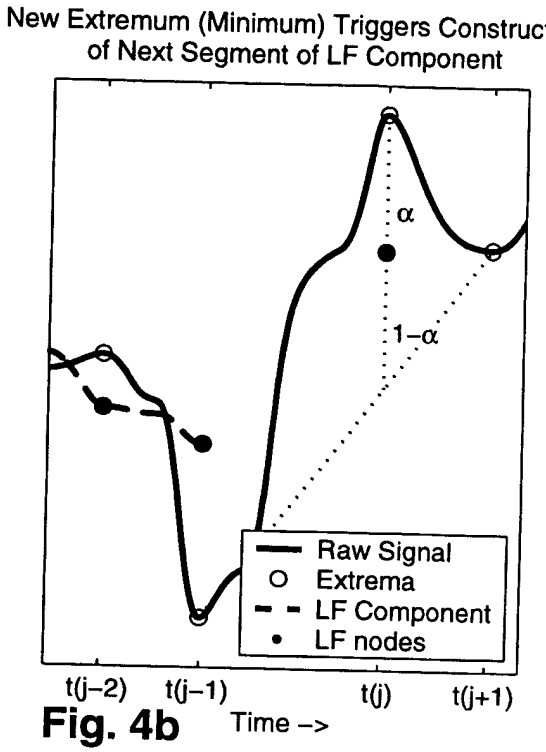


Fig. 4b

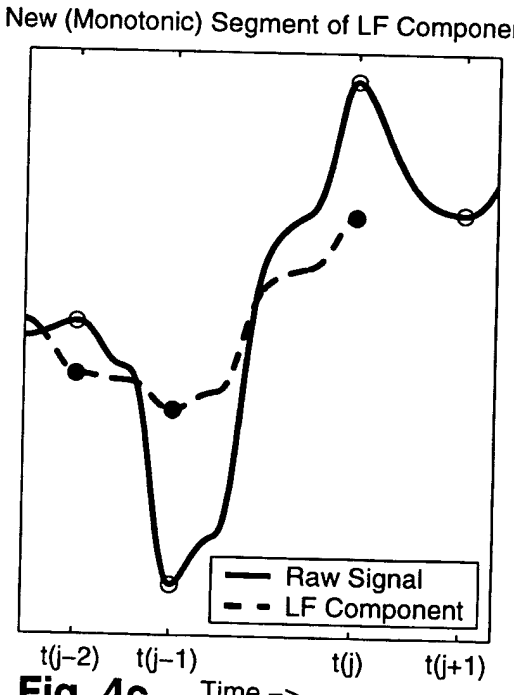


Fig. 4c

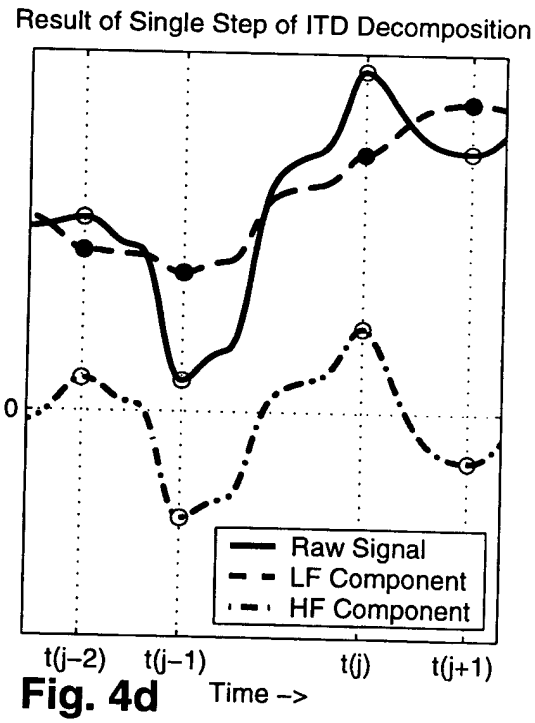


Fig. 4d

Fig. 5a

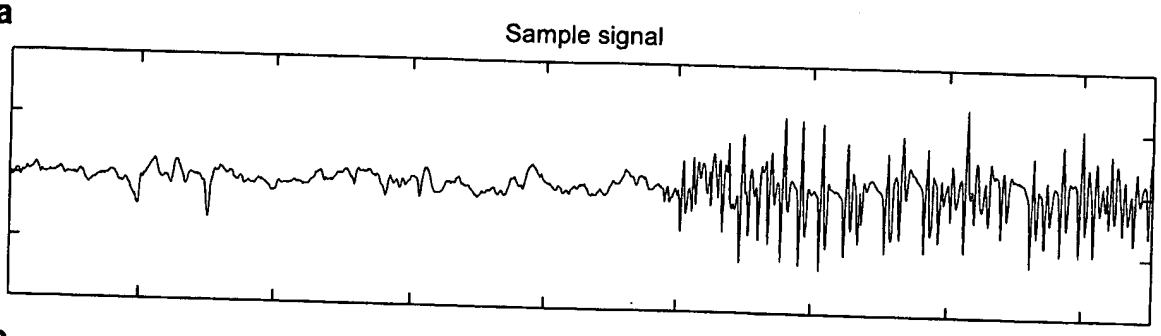


Fig. 5b

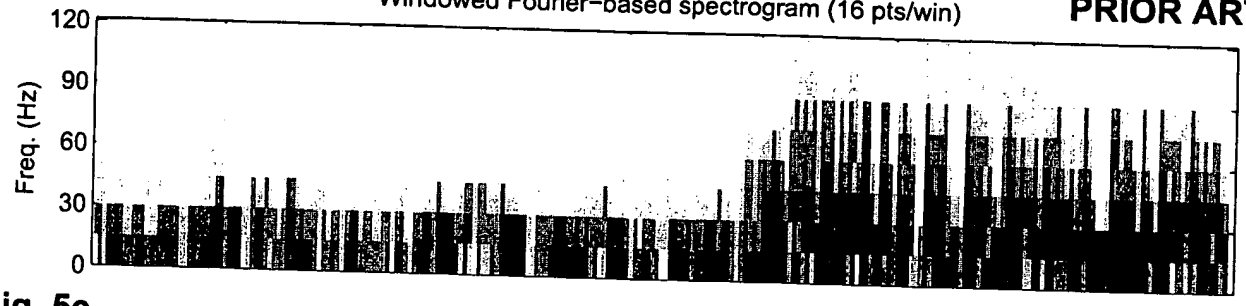


Fig. 5c

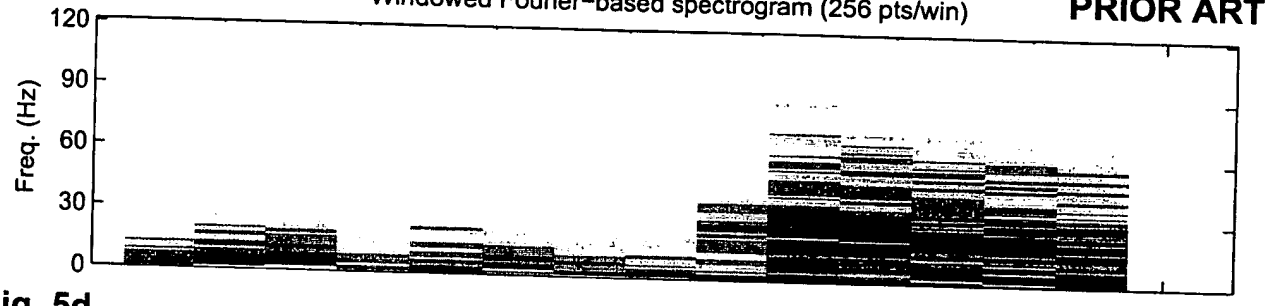


Fig. 5d

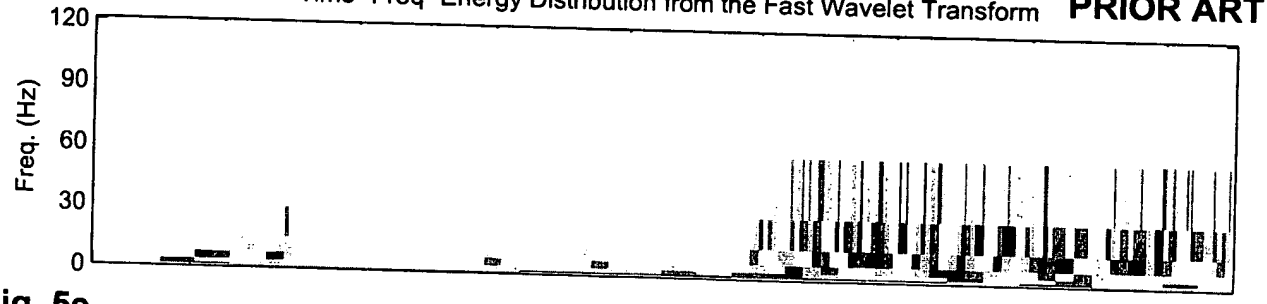
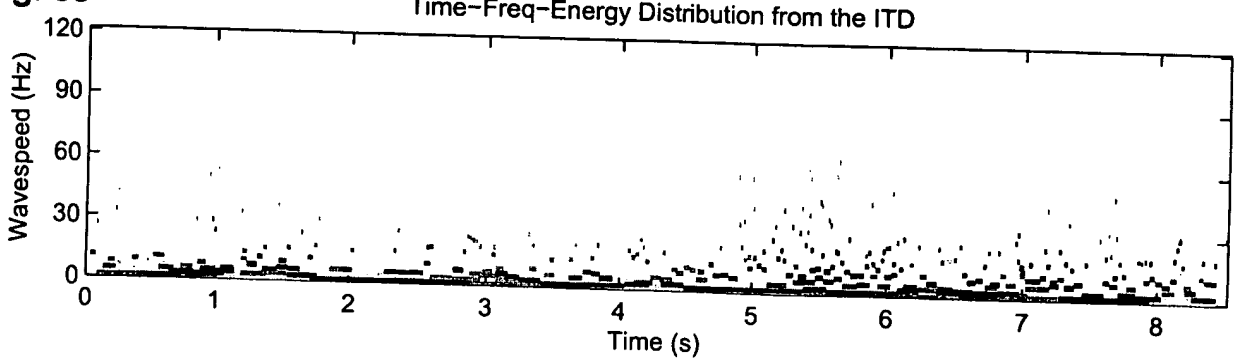


Fig. 5e



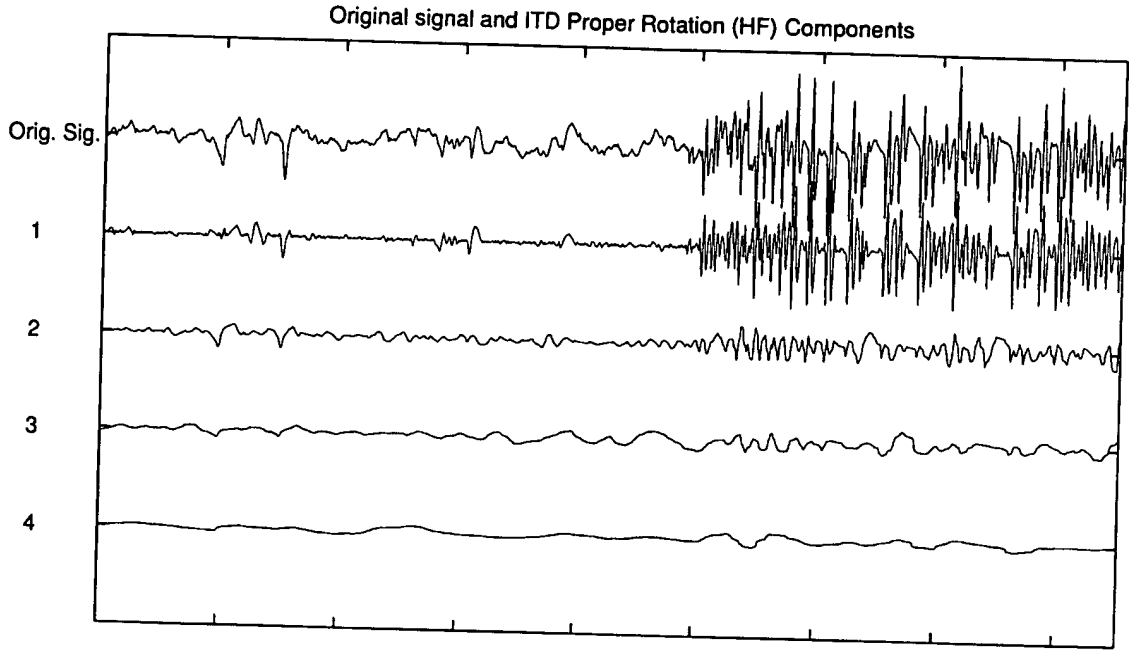

Original signal and ITD Proper Rotation (HF) Components
Orig. Sig.
1
2
3
4

Fig. 5f

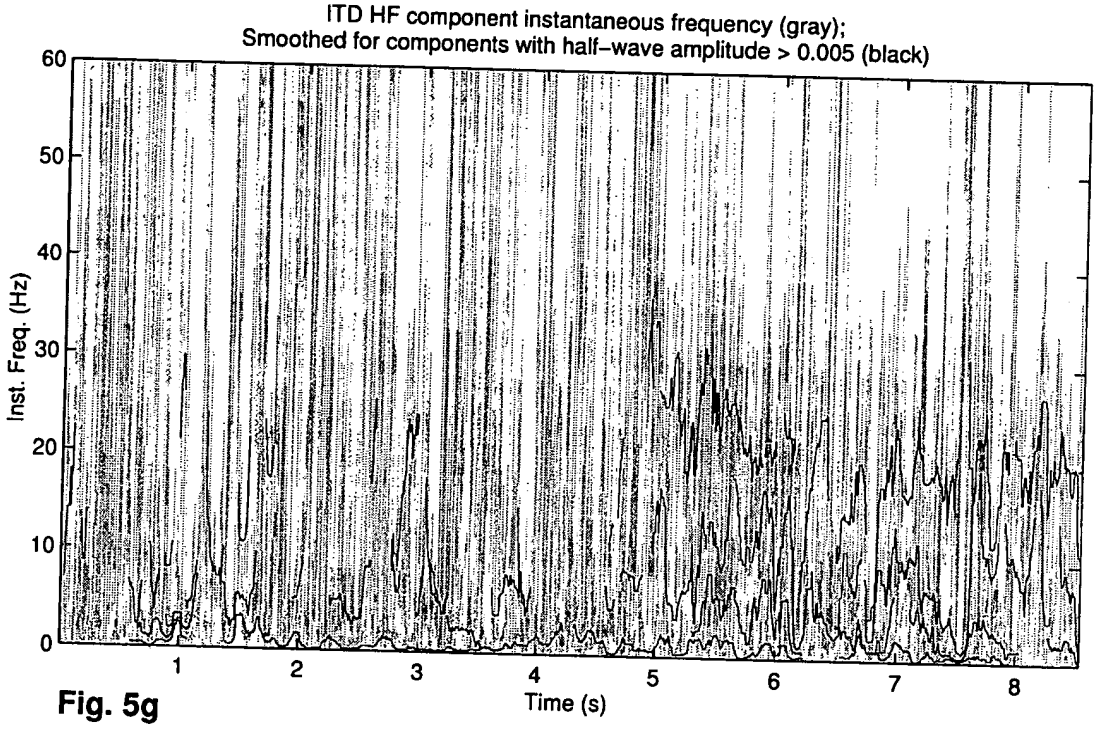

ITD HF component instantaneous frequency (gray);
Smoothed for components with half–wave amplitude > 0.005 (black)
Inst. Freq. (Hz)
60
50
40
30
20
10
0
1
2
3
4
5
6
7
8
Time (s)

Fig. 5g

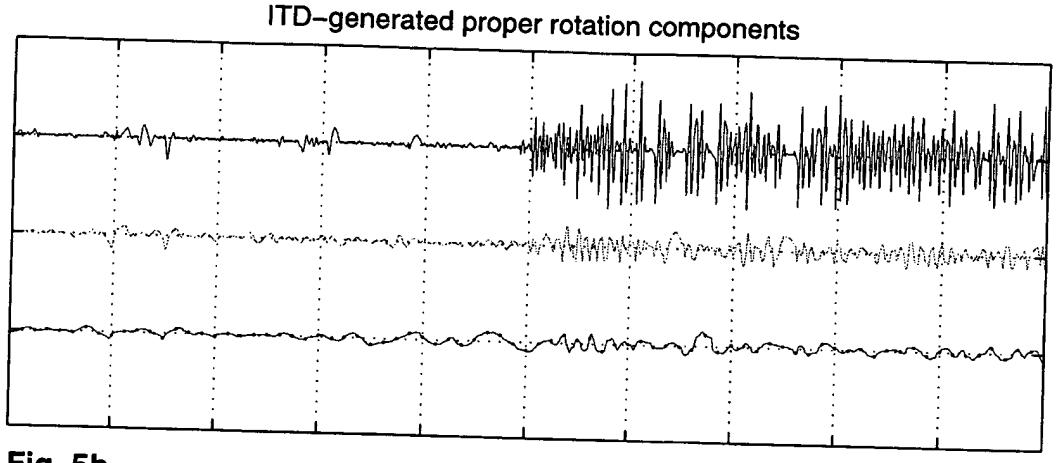


Fig. 5h

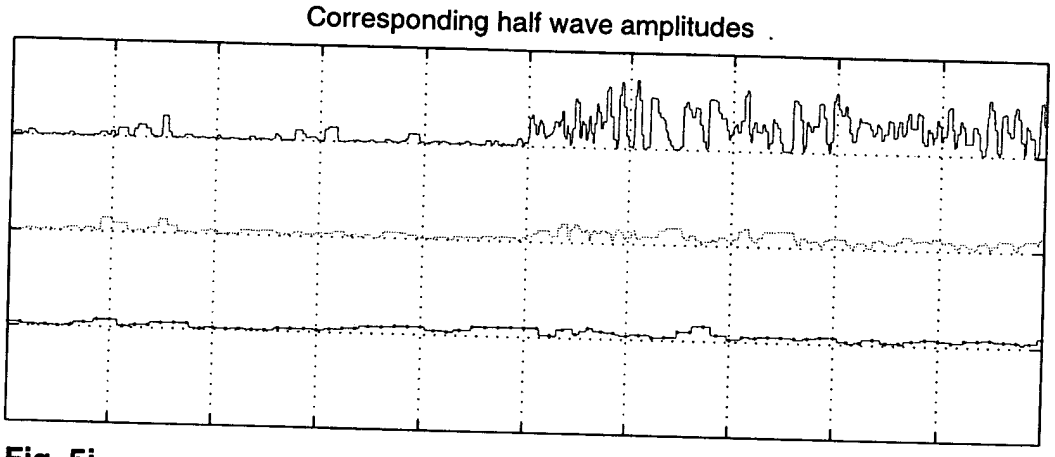


Fig. 5i

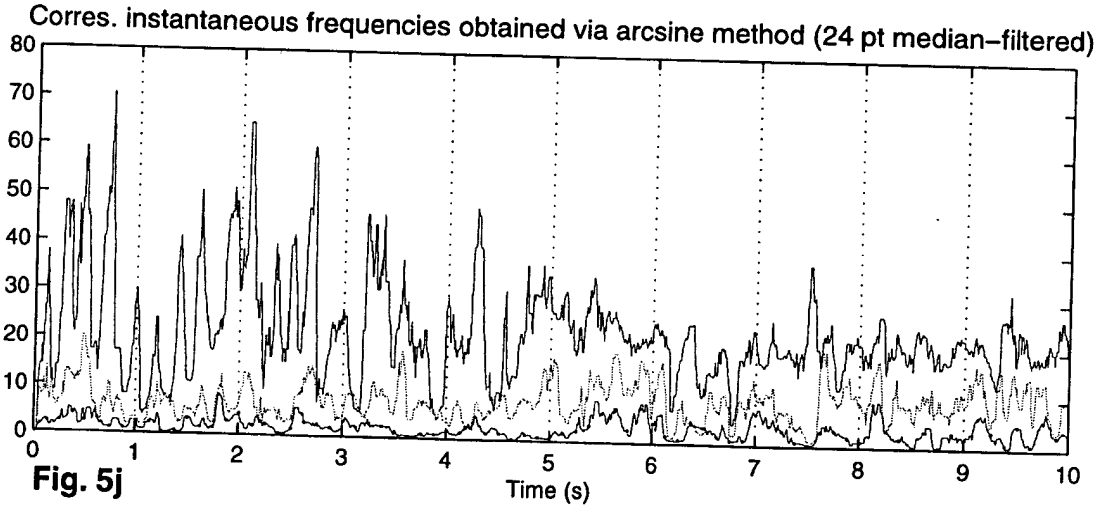


Fig. 5j

Fig. 6a

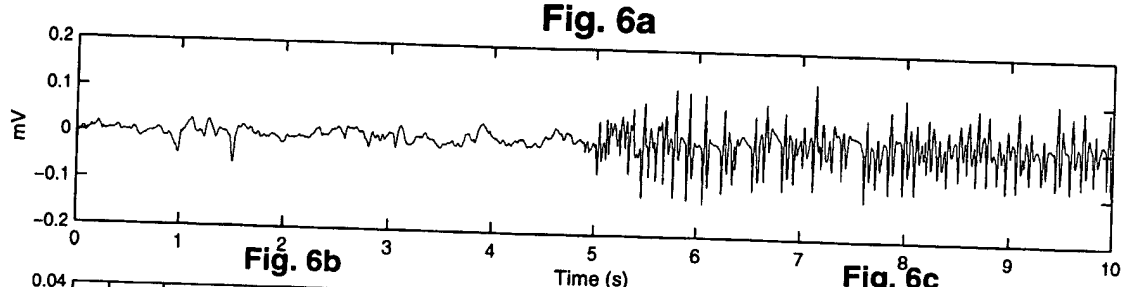


Fig. 6b

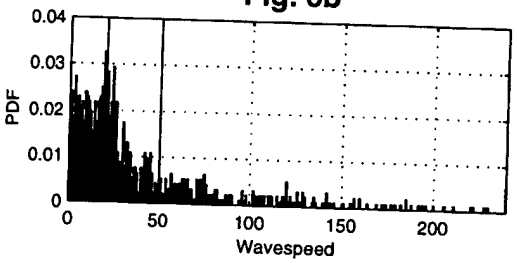


Fig. 6c

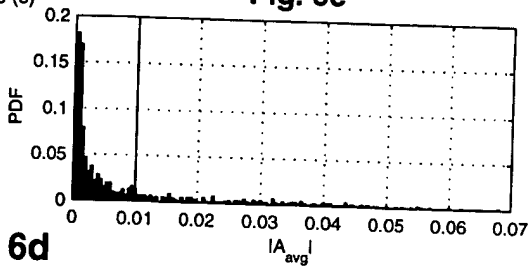


Fig. 6d

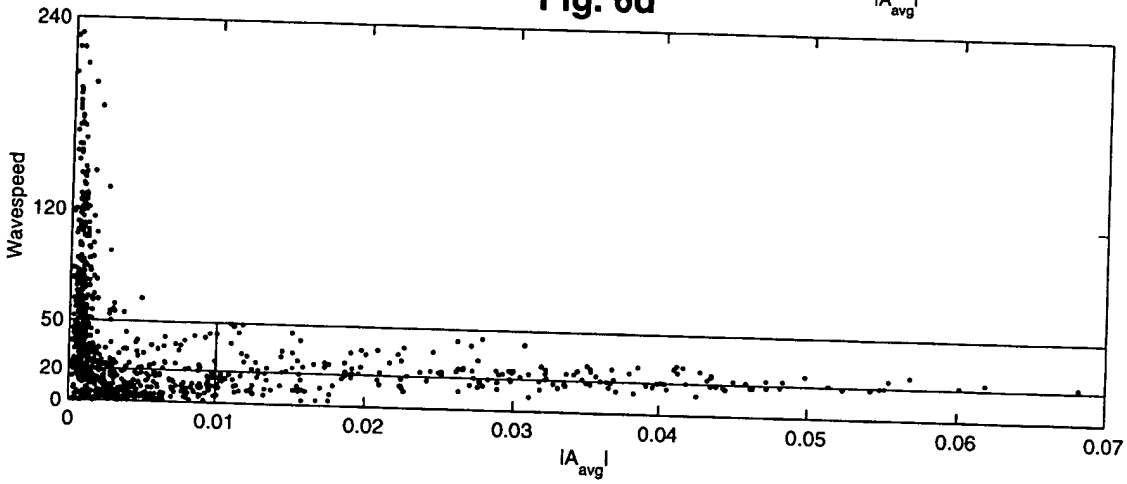
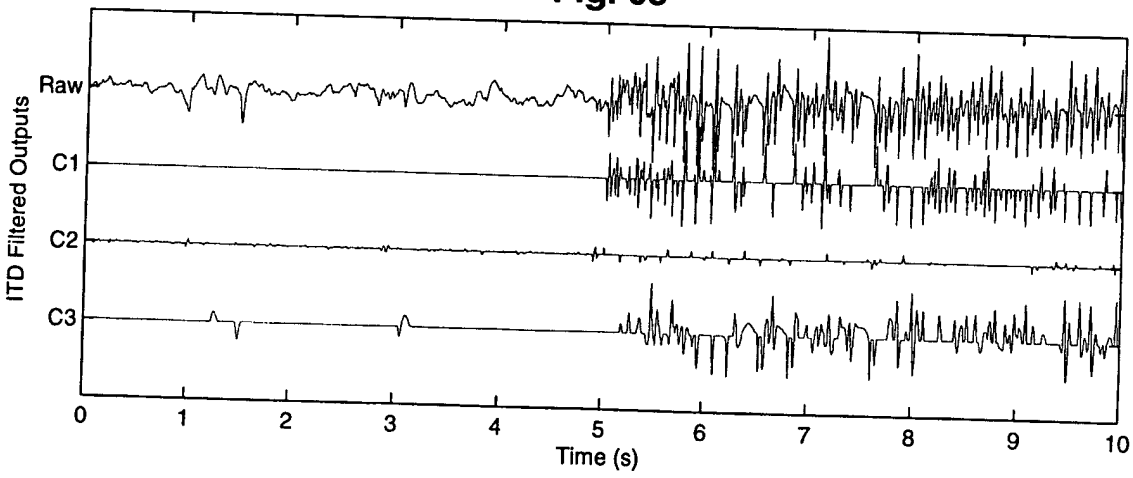


Fig. 6e



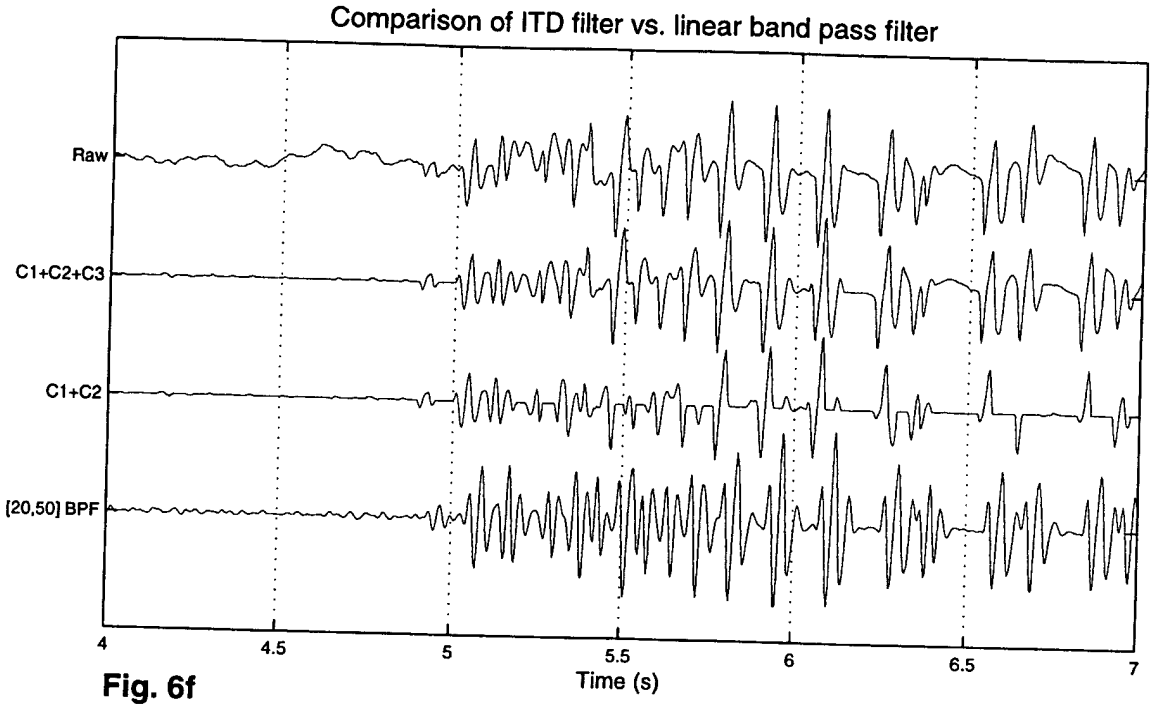

Comparison of ITD filter vs. linear band pass filter
Raw
C1+C2+C3
C1+C2
[20,50] BPF
4
4.5
5
5.5
6
6.5
7
Time (s)

Fig. 6f

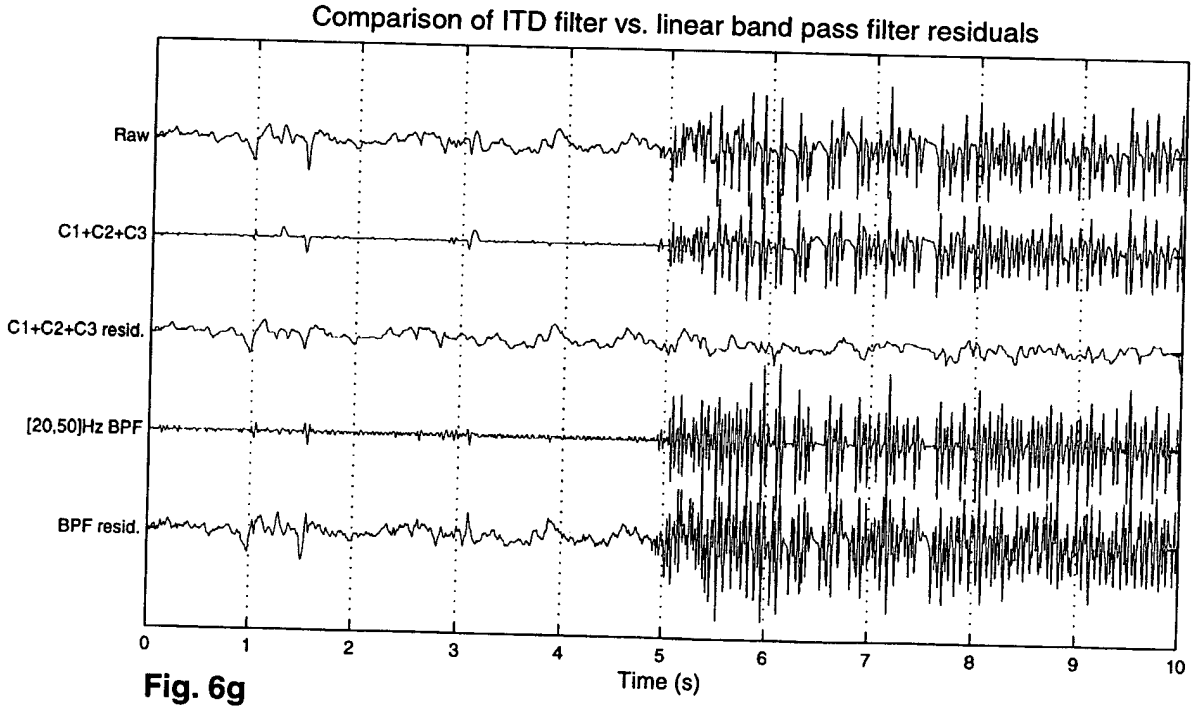

Comparison of ITD filter vs. linear band pass filter residuals
Raw
C1+C2+C3
C1+C2+C3 resid.
[20,50]Hz BPF
BPF resid.
0
1
2
3
4
5
6
7
8
9
10
Time (s)

Fig. 6g

Fig. 7a

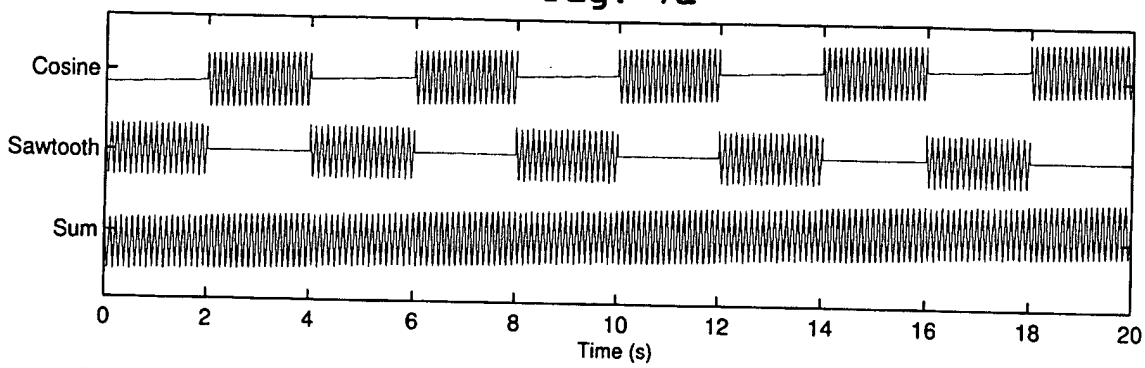


Fig. 7b

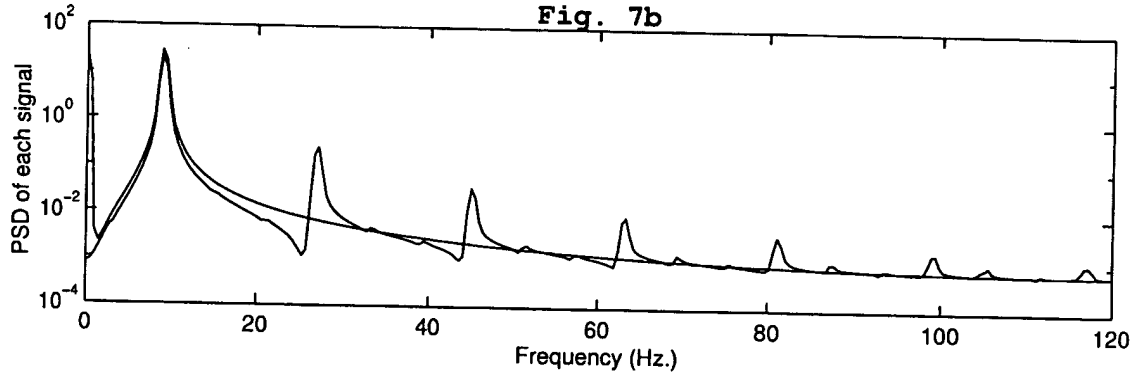


Fig. 7c

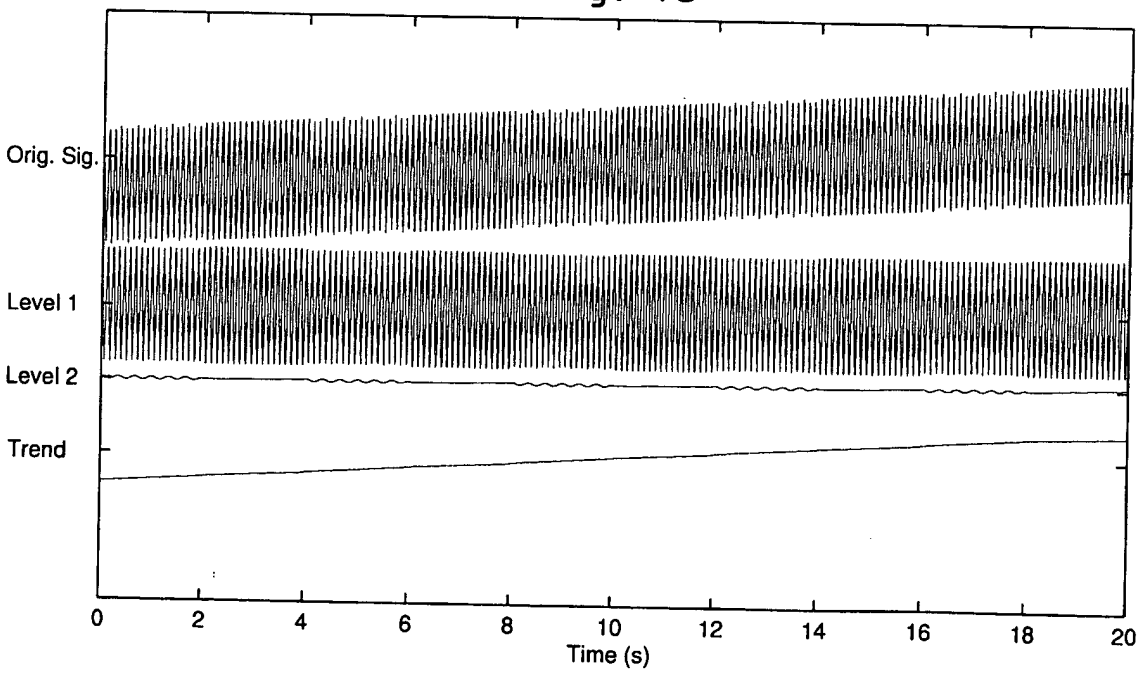


Fig. 7d

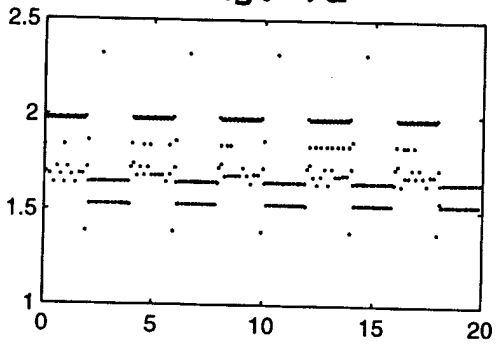


Fig. 7e

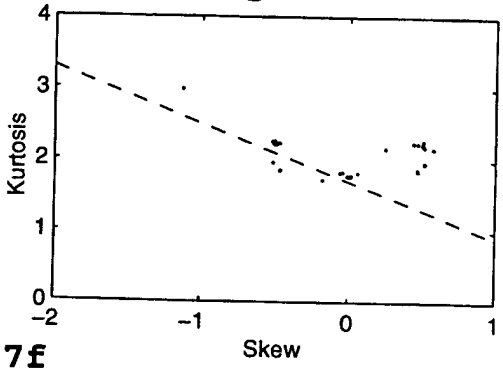


Fig. 7f

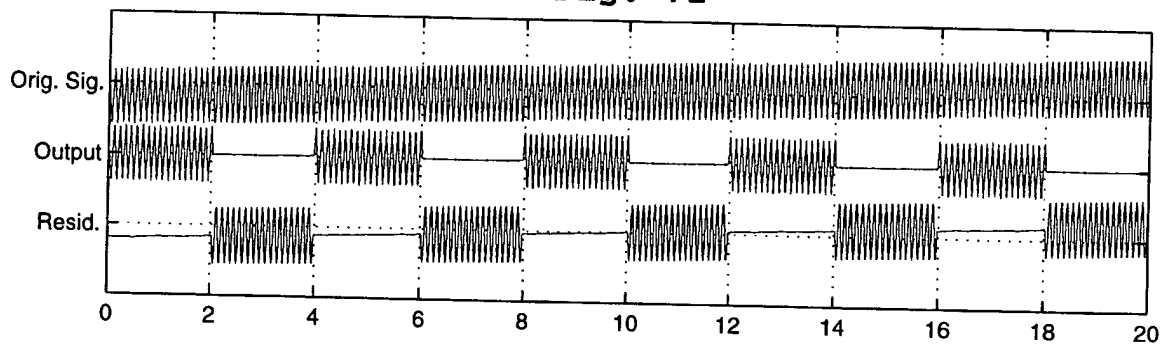


Fig. 7g

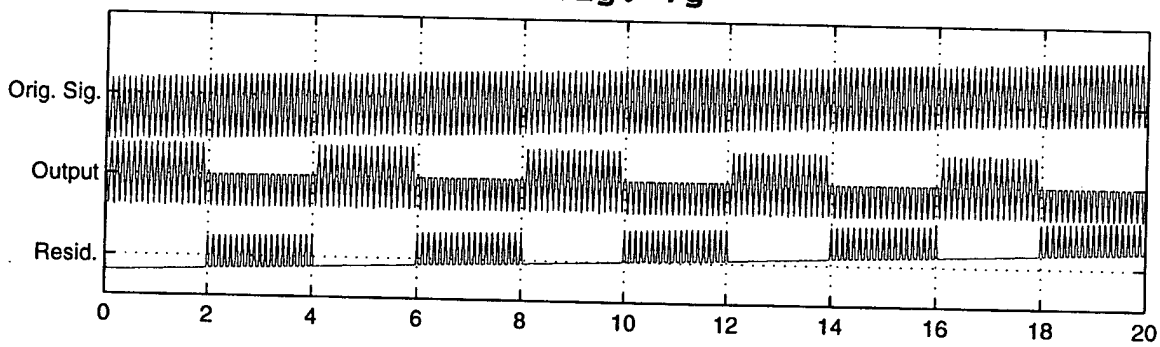
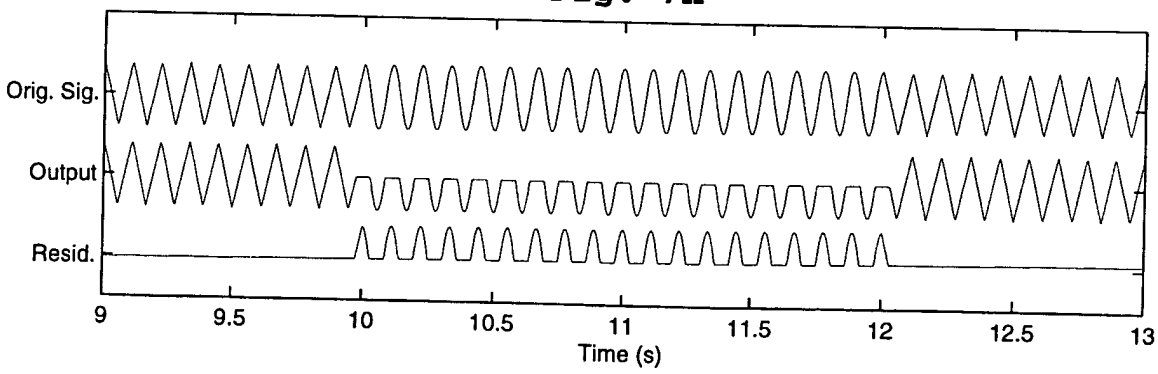


Fig. 7h



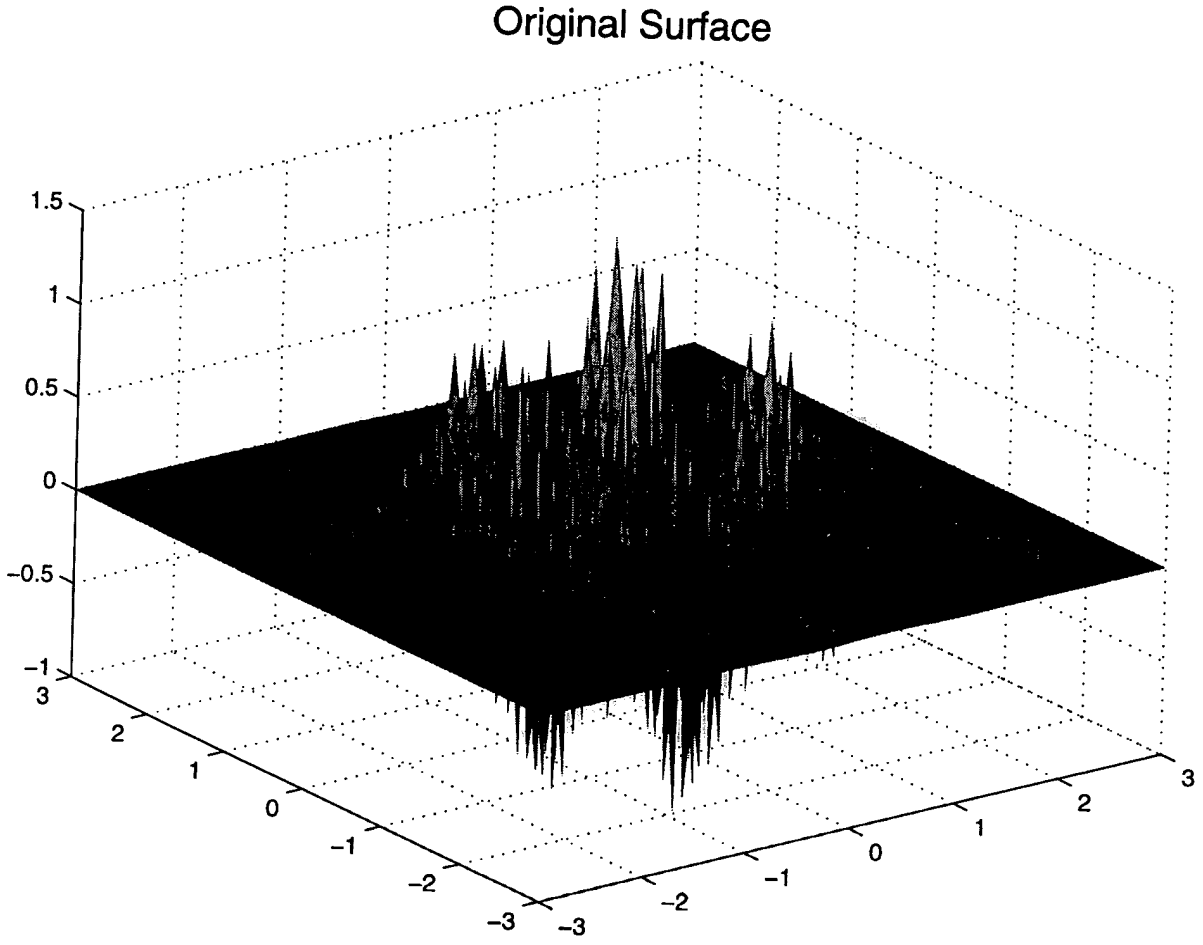


Fig. 8a

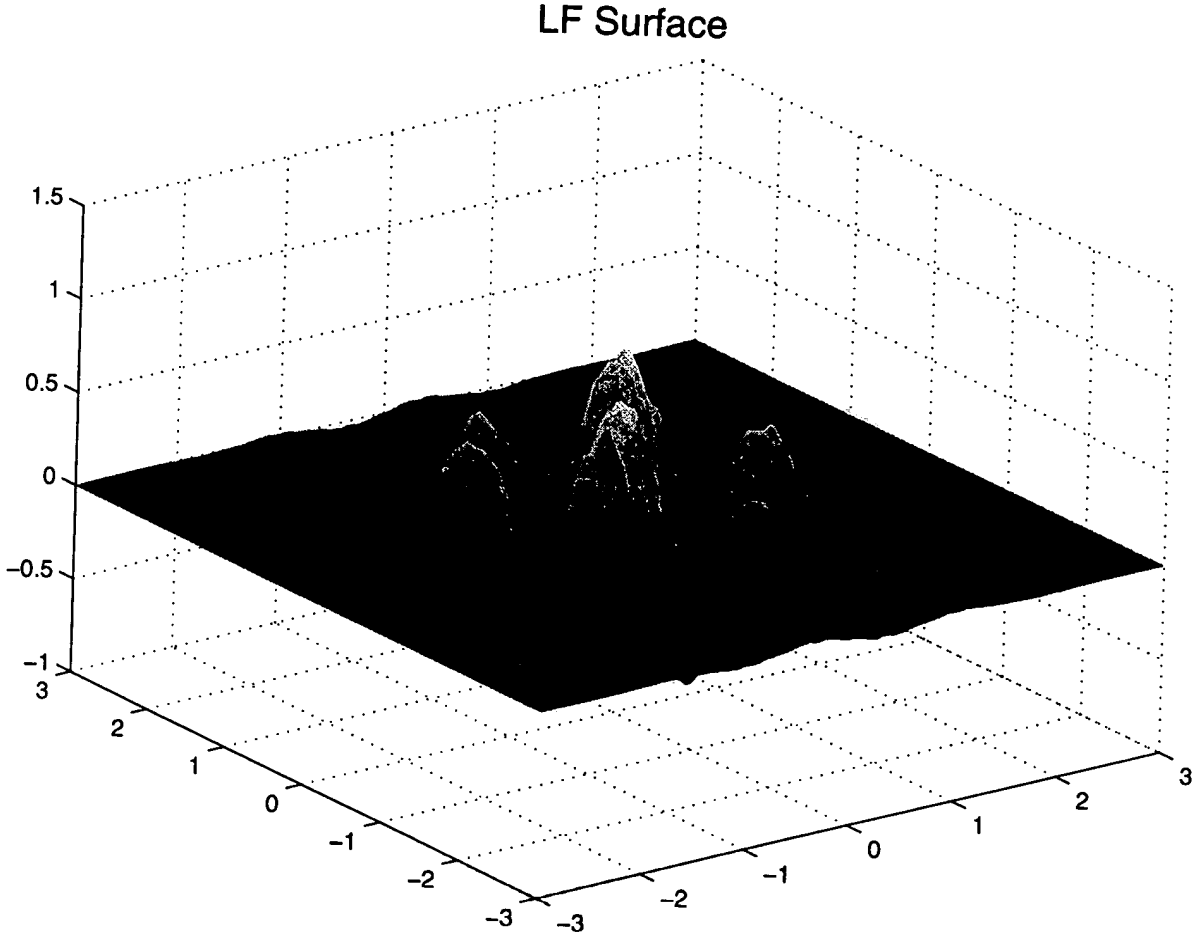


Fig. 8b

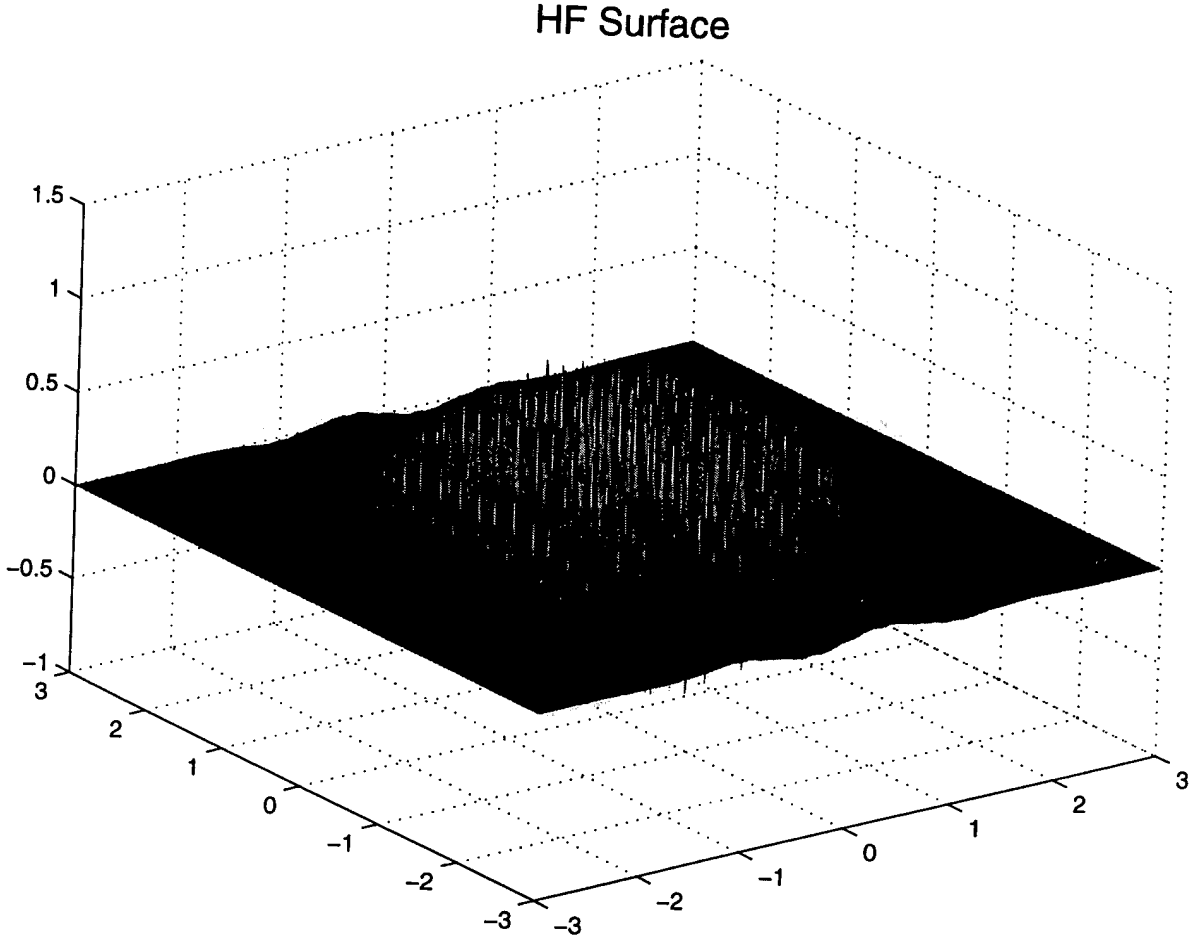
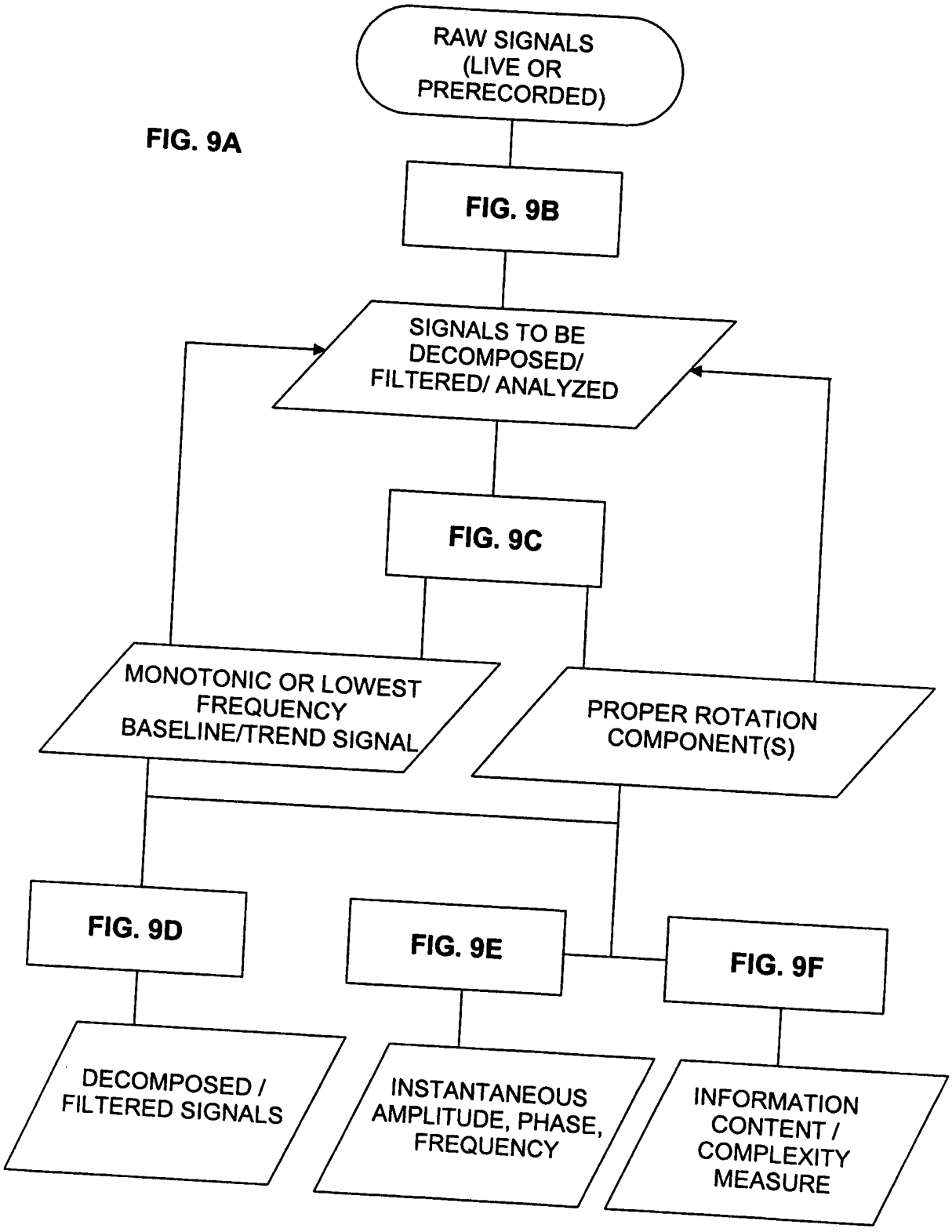


Fig. 8c

FIG. 9A


RAW SIGNALS (LIVE OR PRERECORDED)
FIG. 9B
SIGNALS TO BE DECOMPOSED/ FILTERED/ ANALYZED
FIG. 9C
MONOTONIC OR LOWEST FREQUENCY BASELINE/TREND SIGNAL
PROPER ROTATION COMPONENT(S)
FIG. 9D
FIG. 9E
FIG. 9F
DECOMPOSED / FILTERED SIGNALS
INSTANTANEOUS AMPLITUDE, PHASE, FREQUENCY
INFORMATION CONTENT / COMPLEXITY MEASURE

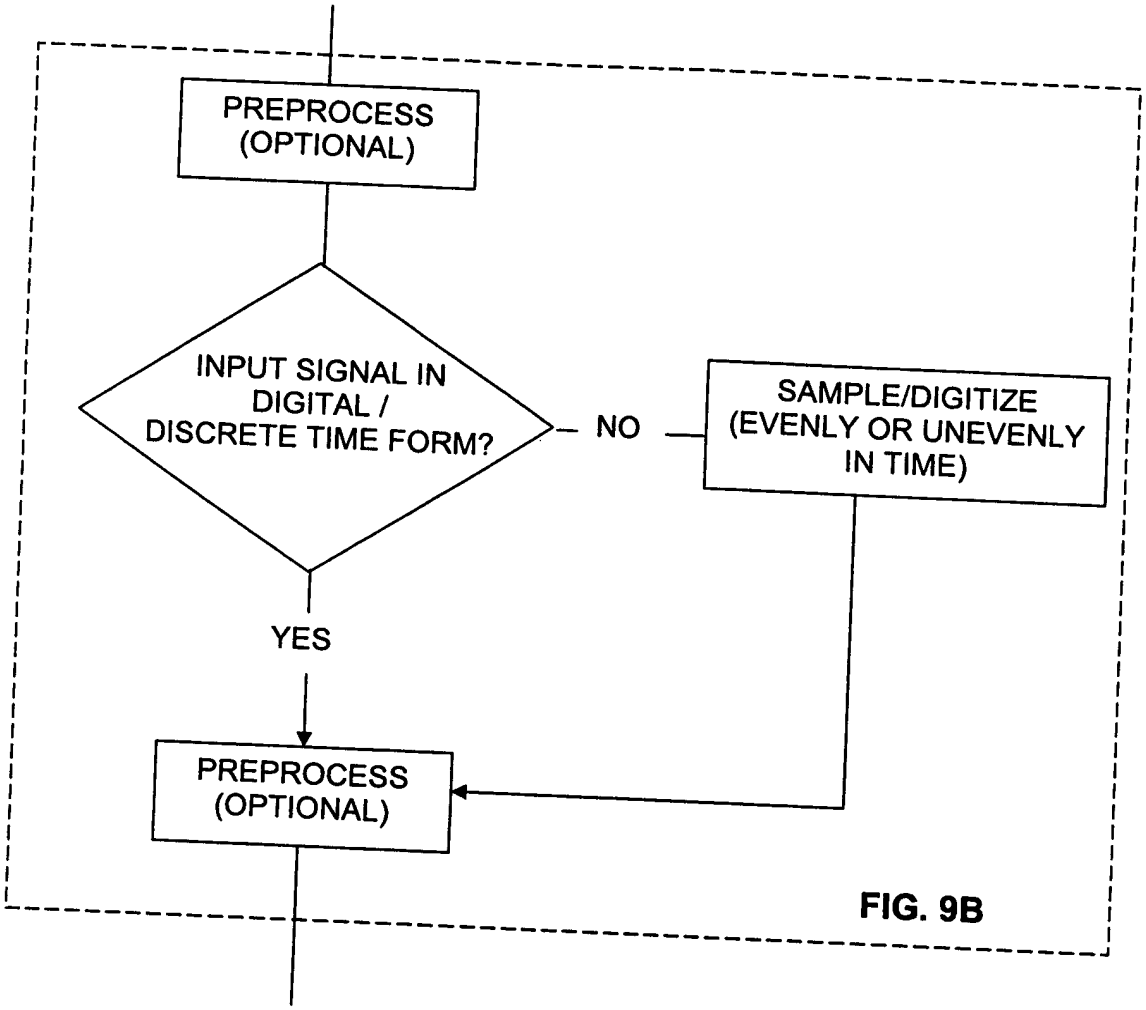

PREPROCESS (OPTIONAL)
INPUT SIGNAL IN DIGITAL / DISCRETE TIME FORM?
NO
SAMPLE/DIGITIZE (EVENLY OR UNEVENLY IN TIME)
YES
PREPROCESS (OPTIONAL)

FIG. 9B

FIG. 9C

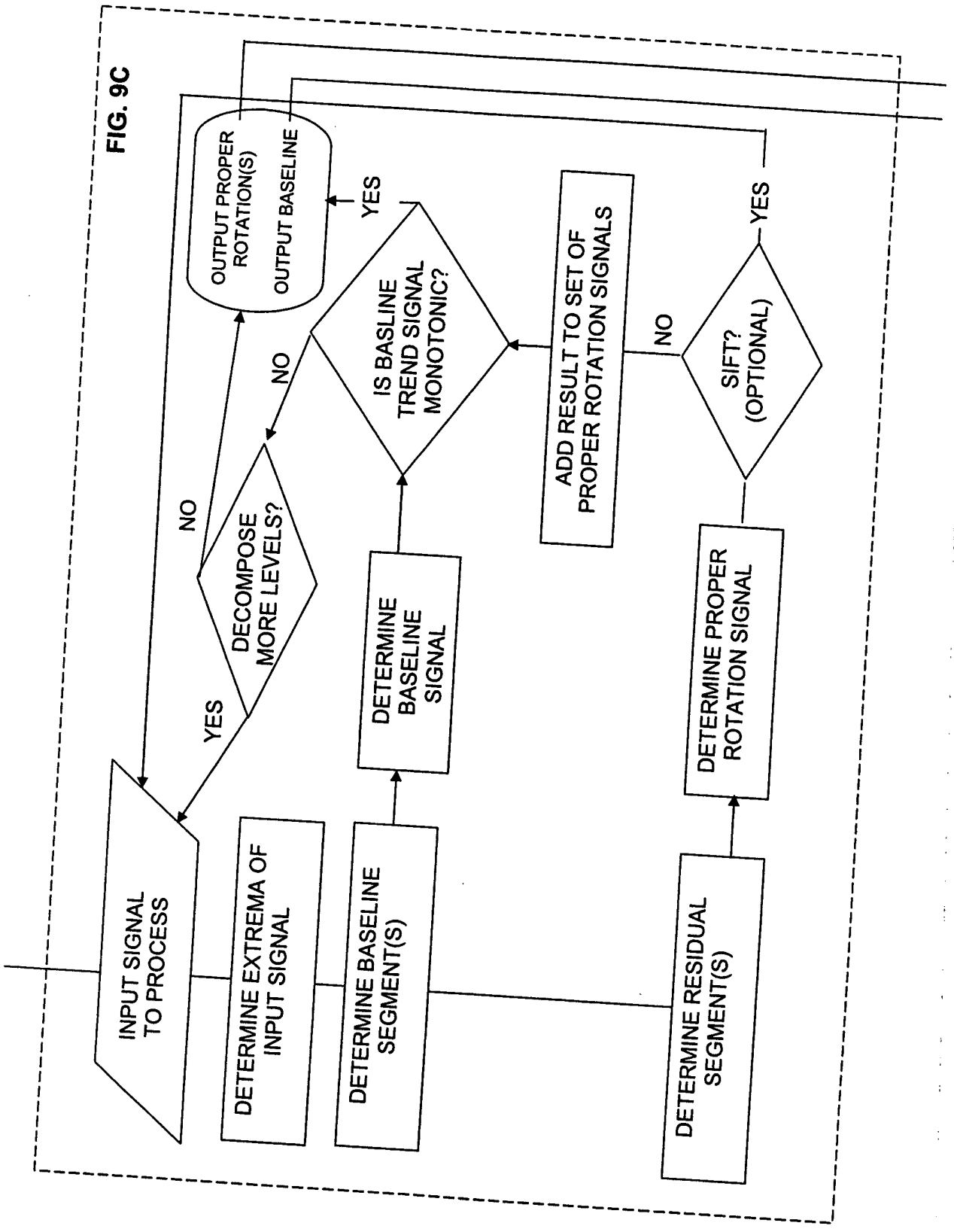

INPUT SIGNAL TO PROCESS
DETERMINE EXTREMA OF INPUT SIGNAL
DETERMINE BASELINE SEGMENT(S)
DETERMINE RESIDUAL SEGMENT(S)
DETERMINE BASELINE SIGNAL
DETERMINE PROPER ROTATION SIGNAL
DECOMPOSE MORE LEVELS?
IS BASLINE TREND SIGNAL MONOTONIC?
SIFT? (OPTIONAL)
ADD RESULT TO SET OF PROPER ROTATION SIGNALS
OUTPUT PROPER ROTATION(S)
OUTPUT BASELINE
YES
NO
YES
NO
YES
NO

FIG. 9D

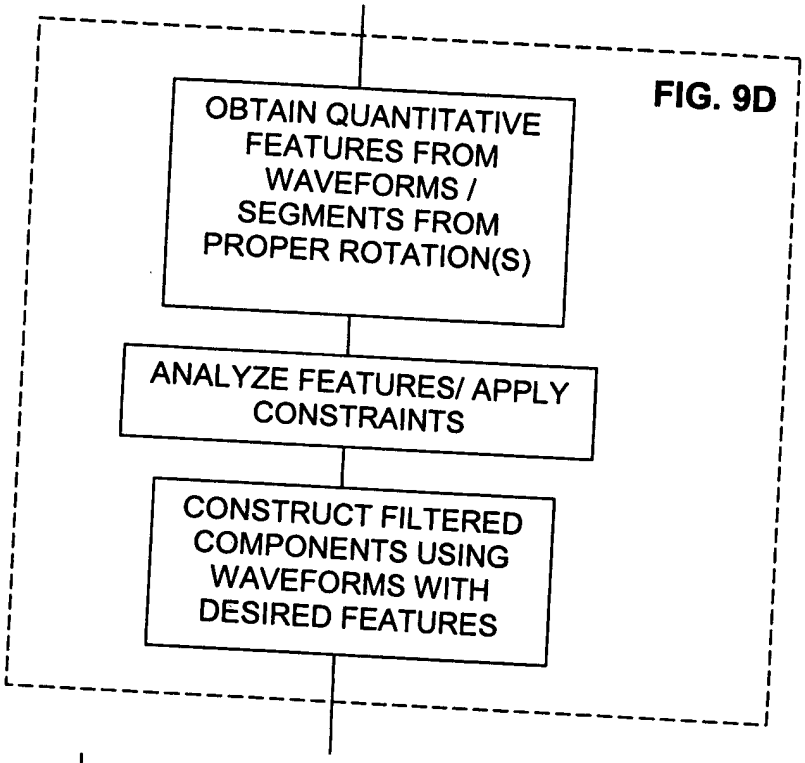
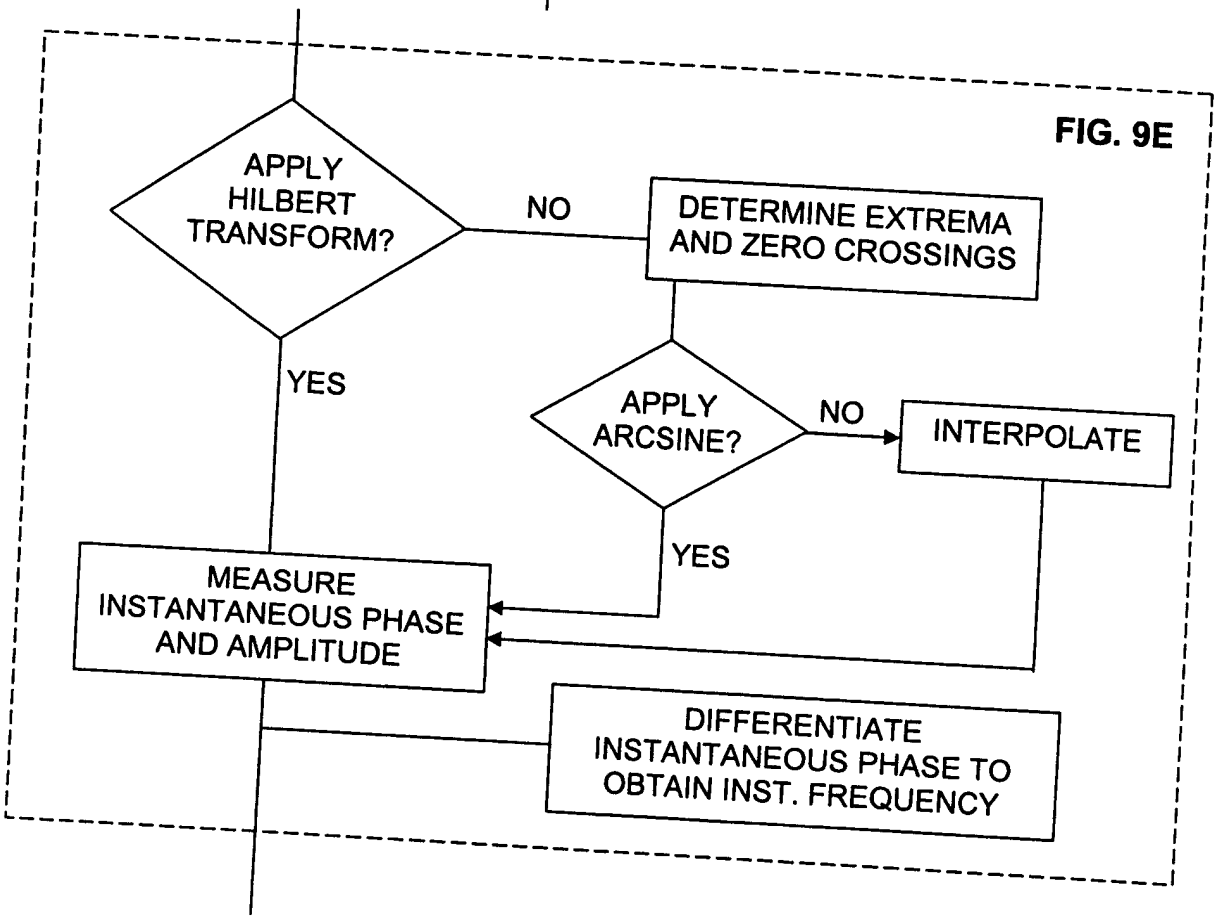

OBTAIN QUANTITATIVE FEATURES FROM WAVEFORMS / SEGMENTS FROM PROPER ROTATION(S)
ANALYZE FEATURES/ APPLY CONSTRAINTS
CONSTRUCT FILTERED COMPONENTS USING WAVEFORMS WITH DESIRED FEATURES

FIG. 9E


APPLY HILBERT TRANSFORM?
NO
DETERMINE EXTREMA AND ZERO CROSSINGS
YES
APPLY ARCSINE?
NO
INTERPOLATE
YES
MEASURE INSTANTANEOUS PHASE AND AMPLITUDE
DIFFERENTIATE INSTANTANEOUS PHASE TO OBTAIN INST. FREQUENCY

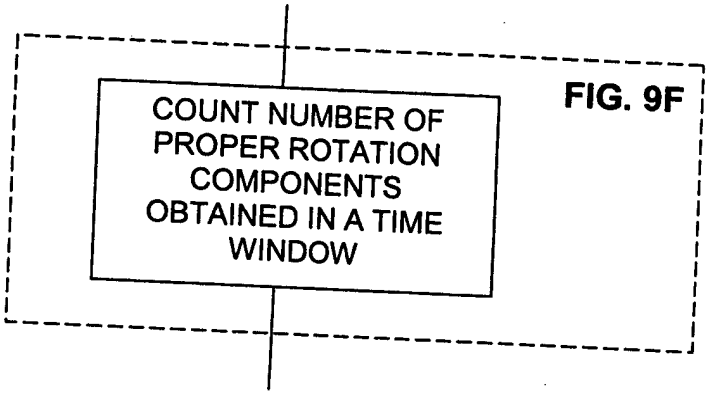

COUNT NUMBER OF PROPER ROTATION COMPONENTS OBTAINED IN A TIME WINDOW

FIG. 9F